(12) UK Patent Application (19) GB (11) 2 224 821 (13) A

(43) Date of A publication 16.05.1990

(21) Application No 8922169.1

(22) Date of filing 02.10.1989

(30) Priority data
(31) 8823229 (32) 04.10.1988 (33) GB

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(51) INT CL[4]
F28D 7/16

(52) UK CL (Edition J)
F4S S5E5 S5E6

(56) Documents cited
GB 2147094 A GB 0654678 A GB 0603646 A
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(58) Field of search
UK CL (Edition J) F4S

(54) Heat exchanger

(57) A heat exchanger comprises a spiral arrangement of parallel tubes (20 ...36) in a jacket. The heat exchange fluid flows in the tubes. The other heat exchange fluid flows through an inlet (48) and impinges substantially normally on the tubes. After passing all the tubes the fluid passes down an outlet passage (40) running generally parallel to the tubes.

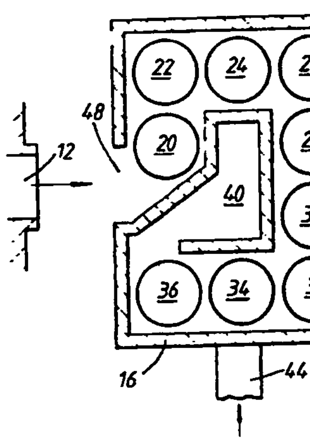

Fig.3.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

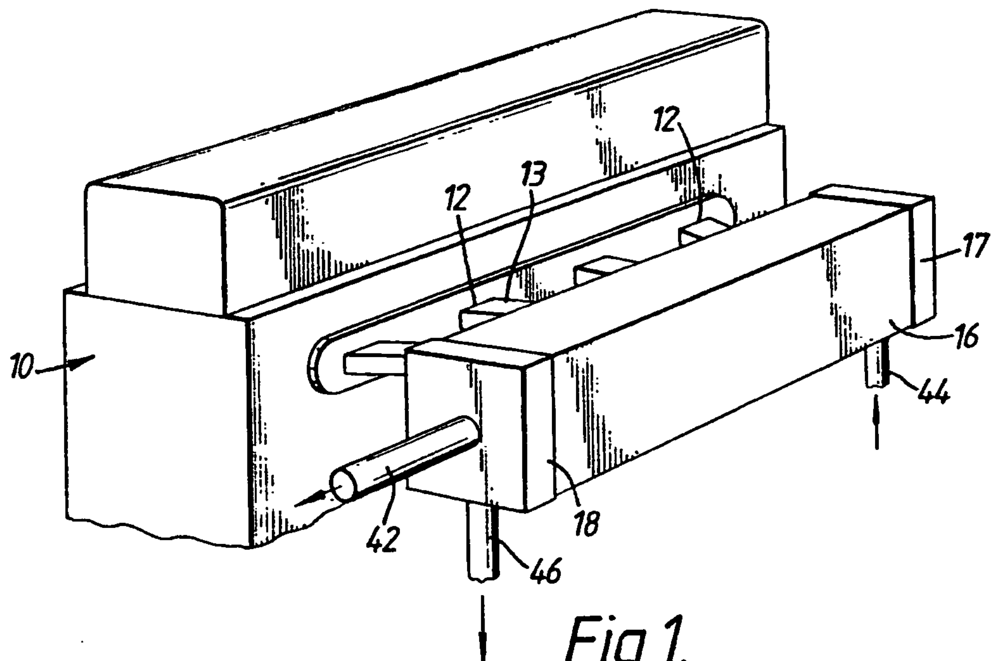

Fig. 1.

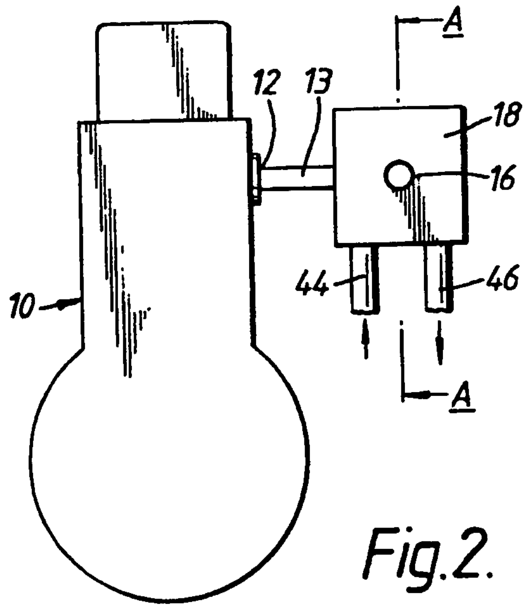

Fig. 2.

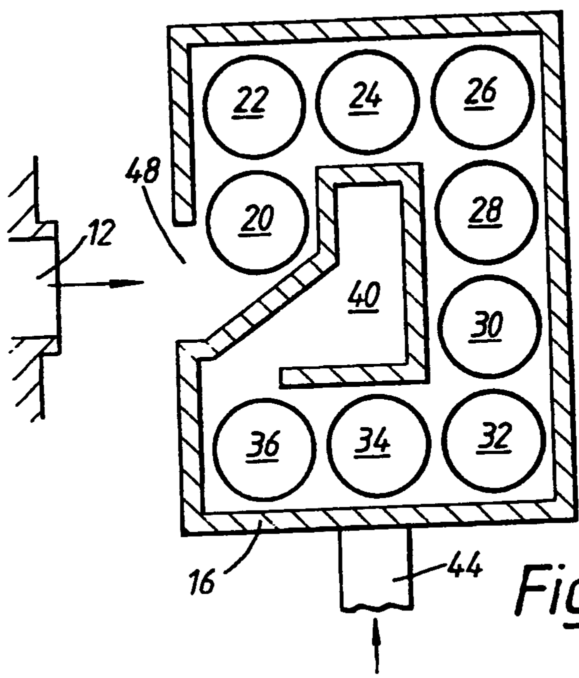

Fig.3.

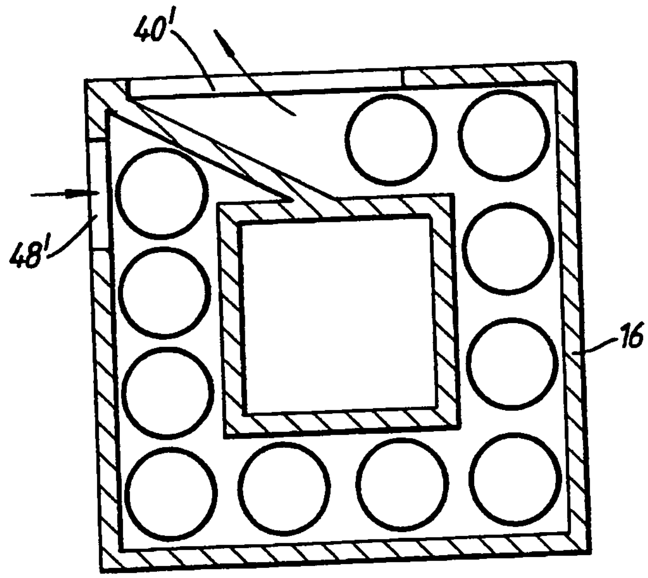

Fig.3A.

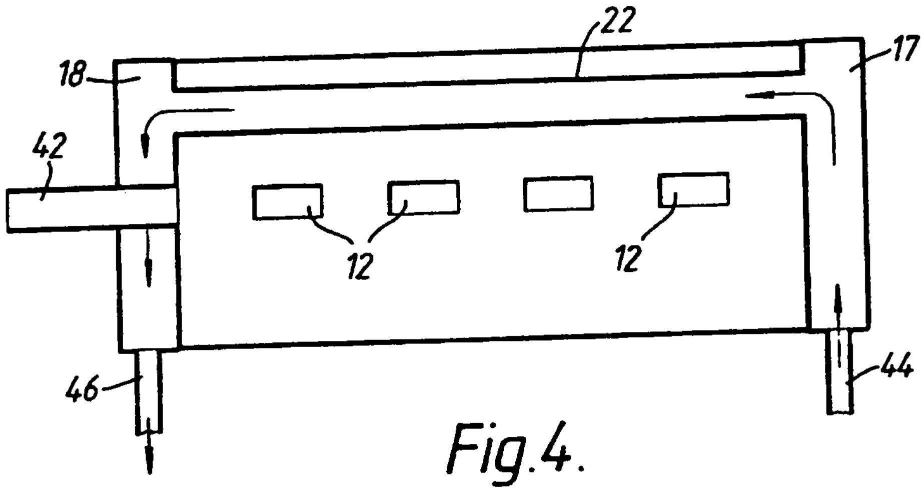

Fig.4.

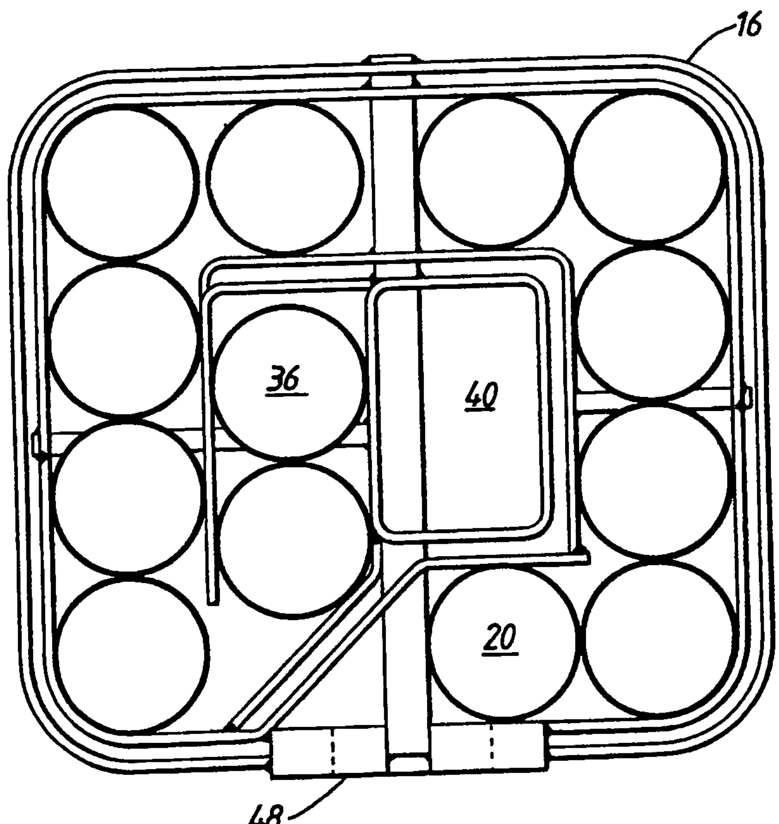

Fig.5.

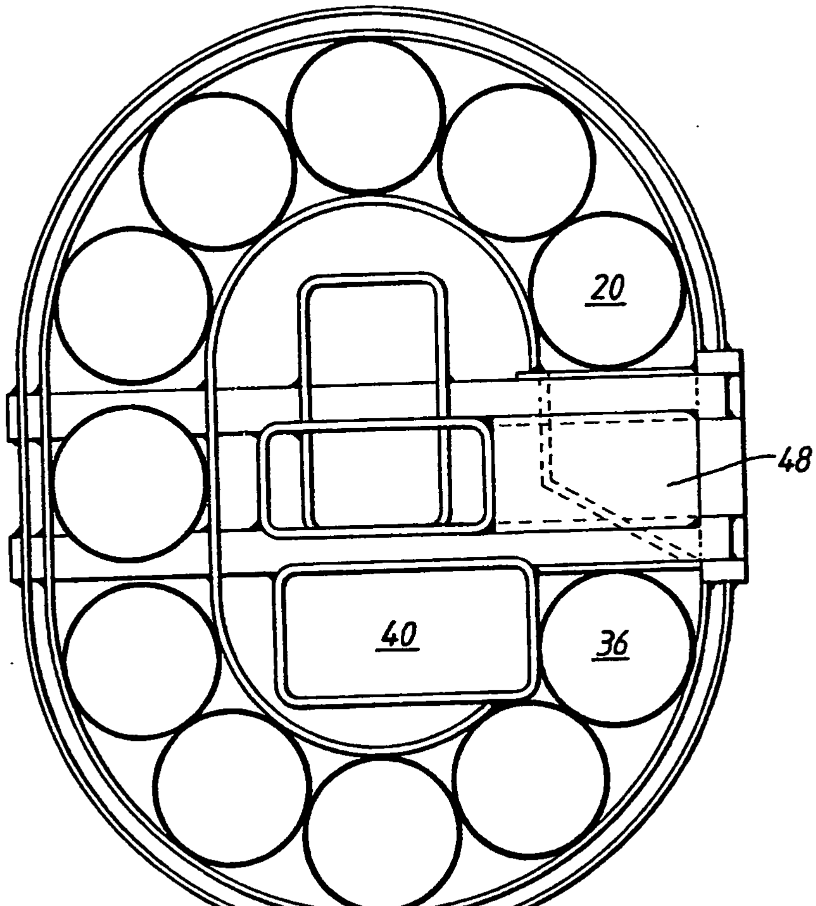

Fig.6.

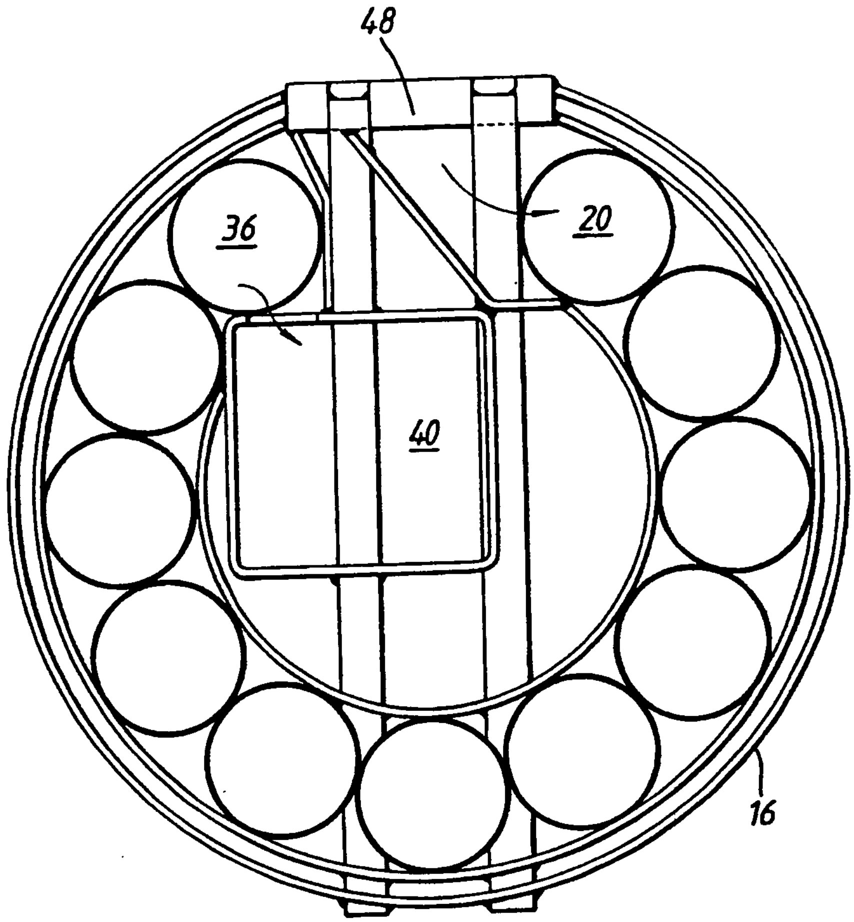

Fig.7.

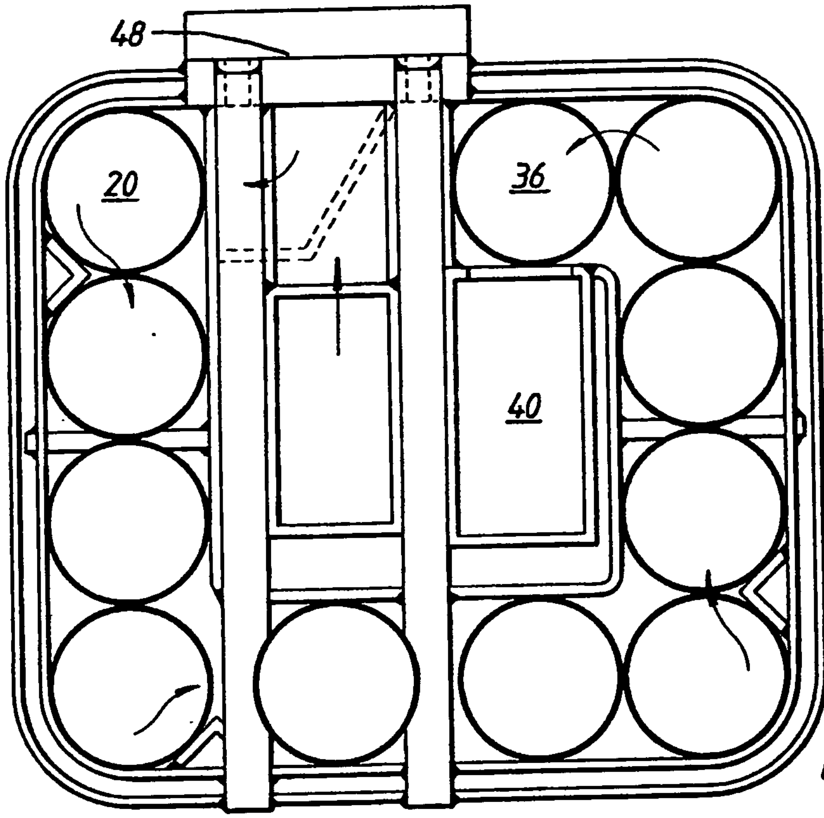

Fig.8.

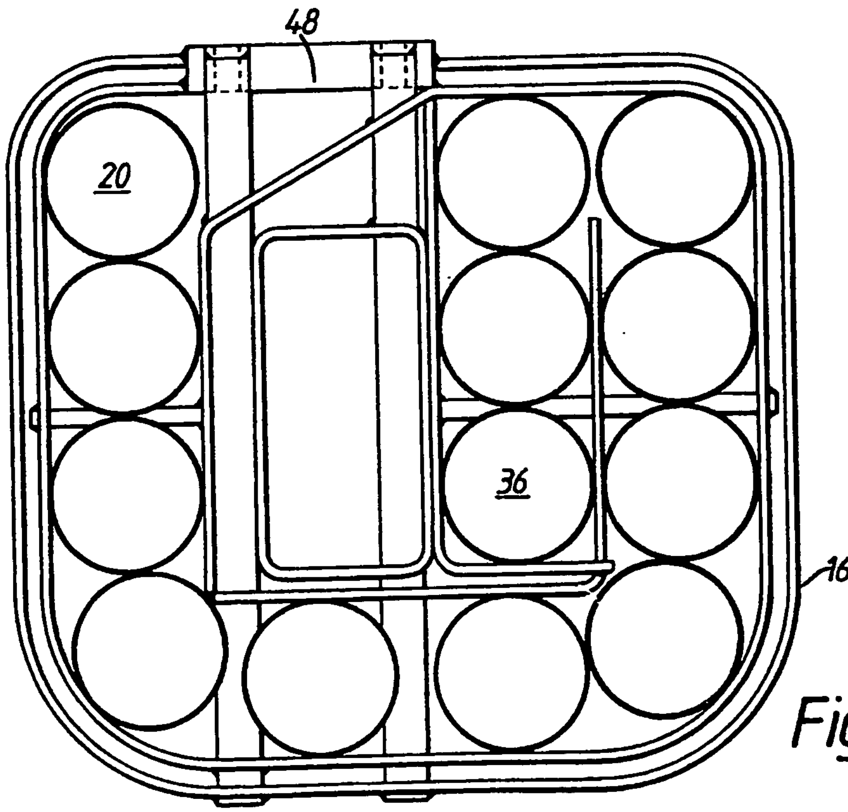

Fig.9.

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HEAT EXCHANGER

This invention relates to a heat exchanger, more particularly but not exclusively, to a heat exchanger for use in cooling the exhaust gases from an internal combustion engine such as may be required for example where the engine is operated in a hazardous environment. By hazardous environment is meant an environment where there is a risk or the presence of flammable materials in the atmosphere in which the engine is operating.

Commonly, such a heat exchanger is disposed in the path of the exhaust gases between the exhaust ports and a flame arrestor. When the gases are expelled from the exhaust ports any flame travelling along the same path is accelerating. Thus, in order to provide as efficient a flame arresting arragement as possible, it is necessary to catch the accelerating flame before it has gathered too much energy. The slower the flame is travelling, the more effective will the flame arresting be.

It is of course conventional in heat exchangers to pass a primary or transfer fluid through a pipe or pipes against which or around which flows a secondary fluid so that heat energy may pass from the secondary fluid to the primary fluid in the case of a cooler and vice versa in a heater. Known exhaust gas coolers, e.g. for a diesel engine, typically comprise a plurality of finned pipes or tubes arranged substantially parallel to one another and through which the primary, coolant, fluid (usually water) passes, the exhaust gas from the

engine (the secondary fluid) entering a chamber surrounding the finned cooling tubes and flowing longitudinally along and around the tubes. The cooled exhaust gas exits at the distal end of the "bundle" of cooling tubes to be passed into the atmosphere optionally through a flame arrestor, silencer or whatever other treatment may be required.

The number and length of finned tubes, and of course the flow of cooling fluid through those tubes will be determined by the anticipated operating temperature of the engine and the required level of cooling. For operation in hazardous environments, that usually requires a fairly bulky and expensive array of such tubes.

It is an object of the present invention to provide an improved heat exchanger, more particularly but not exclusively for use in cooling the exhaust gases from an internal combustion engine.

According to one aspect of the present invention, a heat exchanger comprises a jacket containing a plurality of heat exchanger tubes arranged generally parallel to one another, the jacket wall having a fluid inlet to direct fluid generally normally across the tubes and a fluid outlet.

The primary fluid flow through the pipes is preferably directed through each of the finned tubes or pipes in one direction only, that is in parallel. It may in appropriate circumstances be in series or in a mixture of parallel and series flow. The secondary fluid flow

preferably passes over the pipes at least partially in series, that is to say, that the exhaust gas passes over and around the pipes one after the other on its way from what amounts to radial inlet to an outlet.

The heat exchanger in a preferred form of the invention is a cooler for exhaust gases emanating from an internal combustion engine. The heat exchanger in those circumstances preferably has substantially radially arranged inlets meeting directly or indirectly with the exhaust ports of an internal combustion engine. As the exhaust gas enters the chamber surrounding the plurality of pipes, it first impinges a pipe located substantially adjacent the inlets, flows around that pipe and then flows onto the next pipe and so on. The pipes are preferably arranged in what is in essence a planar spiral path when viewed in section so that the cooled exhaust having flowed over the last of the pipes is adjacent the axis of the heat exchanger from which point it may be expelled in a direction at or closely parallel to the axis.

According to a further aspect to the invention, an internal combustion engine assembly comprises a heat exchanger substantially as defined above, the inlet ports of the heat exchanger being connected directly or indirectly to the exhaust ports of the engine. The substantially axial outlet of the cooled exhaust gas from the heat exchanger may be vented to atmosphere or optionally passed through such further treatment means as may be appropriate for example, a flame arrestor or a silencer.

The heat exchanger may be bolted directly into the engine e.g. using studs which pass through the exchanger, or by using an adapter plate to avoid studs passing through the exchanger.

Using this aspect of the invention as an example of heat exchangers embodying the general inventive principle, the following features should be noted:-

(1) Exhaust gas exiting along the longitudinal axis of the engine immediately impinges on preferably a single length of finned tube, placed at 90° to the exiting exhaust gas flow. The tube will extend along the full longitudinal axis of the engine. The duct enclosing the finned tube is preferably no wider than the diameter of a single finned tube and equal in length to that of the tube. The aim is to concentrate the exhaust gas flow in as narrow a duct as possible to maximise the flow Renolds Number for increased efficiency.

(2) In existing designs a multiplicity of short finned tubes are arranged in rows of one or more tube widths along a rectangular duct. Short tubes are used to keep the dimensions of the duct as small as possible but this significantly increases the number of tubes that must be welded into header plates. Water flows through all of these tubes in one direction. The water flow velocity in each tube is low because of the number of tubes involved and the construction is time consuming. Using the new configuration the number of tubes is reduced in number by up to 2/3 and the water flow

velocity and therefore Renolds number is much increased so improving efficiently. With fewer tube ends to connect this design is also simpler to construct.

(3) Because the number of finned tubes compared to existing designs is reduced, the length of the flow path through the heat exchanger is reduced and this assists in reducing engine back pressure.

(4) By having the exhaust gas enter normally to the tube it is possible to arrange for the gases from each exhaust port to enter the heat exchanger along a separate path. Thus, the path can be made as short as possible, so that the effectiveness of the flame arrestor is optimised, by positioning the inlet for each exhaust port along a single first tube. The potential flame path can be further shortened by arranging the flame trap against an outlet also normal to the tubes.

The present invention may be put into practice in various way and a number of specific arrangements will now be described, by way of example, with reference to the accompanying drawings in which:-

FIGURE 1 is a schematic perspective view of the other part of the block of an internal combustion engine to which has been affixed a heat exchanger according to the present invention;

FIGURE 2 is an end view of the arrangement of Figure 1;

FIGURE 3 is a section through the heat exchanger shown in Figures 1 and 2, and

FIGURE 4 is a partial section along the lines A-A at Figure 2, and

FIGURES 5 to 9 are sectional views of alternative arrangements of heat exchanger equivalent to that shown in Figures 1 to 3.

Referring to the drawings, Figures 1 to 4 show an engine block 10 of a four-cylinder diesel engine having four exhausts ports as at 12, each of which is connected through an individual exhaust pipe to an exhaust gas cooler 16. The exhaust gas cooler 16 comprises a plurality of pipes 20 to 36 arranged with their axes substantially parallel as shown in the sectional drawing at Figure 3. The pipes are conventional finned heat exchanger pipes although the fins are not shown in the drawings. The outer wall of the heat exchanger 16 substantially rectangular with an array of pipes 20 to 36 3 x 4 but with the two centre and one further pipe omitted. An outlet conduit 40 is thereby provided connected at one end of the heat exchanger to an outlet pipe 42.

Either end of the heat exchanger 16 is provided with a cooling fluid plenum 17 and 18. The cooling fluid, usually water, will enter the plenum 17 through an inlet pipe 44 and, as better shown in the partial section of Figure 4, pass into the plenum 17, and then through the pipes (shown by example as pipe 22 in

Figure 4), into the plenum 18 and out of the plenum 18 through pipe 46 for disposal or re-circulation. Plenum 18 is an annular chamber through which passes the exhaust pipe 42 as again will be seen more clearly in Figure 4.

The passage of the exhaust gas from e.g. exhaust port 12 is in through an orifice 48 in the heat exchanger housing where it will impinge almost directly on cooling tube 20 substantially at right angles to the axis of cooling tube 20. The output from the other three exhaust ports will do the same at spaced intervals along pipe 20. As the slightly cooled exhaust gas passes from the circumference of pipe 20, it will then impinge the cooler surface of pipe 22 and so on through the array of pipes until it passes pipe 36. From there it will be carried into the conduit 40 and thereafter out through pipe 42 in a suitably cooled state.

In a modification of the heat exchanger described, which is particularly suited to flame arresting applications in which as short a path as possible is required between the engine exhaust port and the flame arrestor itself, the outlet for the cooled gases is provided on one of the sides away from the exhaust ports. This is illustrated in Figure 3A. The cooled gas exits from the heat exchanger normally from the tubes through an outlet 40′ having entered through an inlet 48′ and passed serially past the tubes in a radial path.

Figures 5 to 9 are similar arrangements with different

overall shapes, numbers of pipes etc. The figures have been numbered with the equivalent numbers as shown in Figure 3.

The present invention relies on the use of a plurality of cooling tubes disposed to receive the hot exhaust gas moving in a direction substantially at right angles to the axis of the tubes as opposed to moving parallel to the axis of the tubes as is the case with conventional arrangements. That, coupled with the features of the progressively cooled gas impinging upon each of the tubes in series as it flows through the heat exchanger, and the axial or normal output of the cooled gas from the heat exchanger provides a heat exchanger of simple and economical construction and moreover one which provides a highly efficient cooling regime using a lesser number of tubes than would otherwise have been the case. Of course as the number of tubes can be reduced, the through-flow of cooling fluid can be increased. Moreover, being able to dispose the array of heat exchange pipes substantially parallel to the axis of the engine is beneficial in terms of the subsequent ducting required for the exhaust gas e.g. in terms of location of silencers, spark arrestors or other safety devices.

CLAIMS

1. A heat exchanger comprising a jacket containing a plurality of heat exchanger tubes arranged generally parallel to one another, the jacket wall having a fluid inlet to direct fluid generally normally across the tubes and a fluid outlet.

2. A heat exchanger as claimed in claim 1 wherein the outlet is arranged to allow the fluid to exit along a direction generally parallel to the tubes.

3. A heat exchanger as claimed in claim 1 wherein the outlet is arranged to allow the fluid to exit normally to the tubes.

4. A heat exchanger as claimed in claim 1, 2 or 3 wherein the jacket comprises a baffle wall arranged to direct the fluid at the inlet across the tubes and/or out parallel to the tubes.

5. A heat exchanger is claimed in claim 4 wherein the baffle is arranged to define a heat exchange fluid path across tubes.

6. A heat exchanger as claimed in claim 4 or 5, wherein the baffle directs the heat exchange fluid across the tubes in series.

7. A heat exchanger as claimed in any of claims 1 to 6, wherein the tubes are arranged generally around the fluid outlet.

8. A heat exchanger as claimed in claim 7, wherein the path around the tubes is generally spiral.

9. A heat exchanger as claimed in any preceding claim wherein the flow is directed serially across the tubes.

10. A heat exchanger substantially as specifically described herein with reference to Figures 3, 5, 6, 7, 8 or 9 of the drawings.

11. An internal combustion engine including a heat exchanger for cooling exhaust gases as claimed in any of the preceding claims.

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